

**Biology**  
**Higher level**  
**Paper 2**

Monday 1 May 2017 (afternoon)

Candidate session number

2 hours 15 minutes

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**Instructions to candidates**

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: answer all questions.
- Section B: answer two questions.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[72 marks]**.



## Section A

Answer **all** questions. Write your answers in the boxes provided.

1. The Chinese soft-shelled turtle, *Pelodiscus sinensis*, lives in salt water marshes. The turtle can live under water and out of water.

These turtles have fully developed lungs and kidneys, however, many microvilli have been discovered in the mouth of *P. sinensis*. A study was undertaken to test the hypothesis that oxygen uptake and urea excretion can simultaneously occur in the mouth.

Initial experiments involved collecting nitrogen excretion data from *P. sinensis*. The turtle urinates both in water and out of water. When in water it allows waste products to be washed out of its mouth. When out of water it regularly dips its head into shallow water to wash its mouth. The table shows the mean rates of ammonia and urea excretion from the mouth and kidney over six days.

	Excretion of nitrogen by the mouth / $\mu\text{mol day}^{-1} \text{ g}^{-1}$ turtle		Excretion of nitrogen by the kidney / $\mu\text{mol day}^{-1} \text{ g}^{-1}$ turtle	
	Turtle submerged in water	Turtle out of water	Turtle submerged in water	Turtle out of water
<b>Ammonia</b>	0.29	0.30	0.63	0.54
<b>Urea</b>	0.90	1.56	0.07	0.73

[Source: Reproduced with permission, Y. Ip *et al.* (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733. [jeb.biologists.org](http://jeb.biologists.org). doi: 10.1242/jeb.068916]

- (a) Deduce whether the excretion of ammonia or urea changes more when a turtle emerges from water.

[2]

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**(Question 1 continued)**

- (b) Compare and contrast the changes in urea excretion in the mouth with the changes in urea excretion in the kidney when a turtle emerges from the water.

[3]

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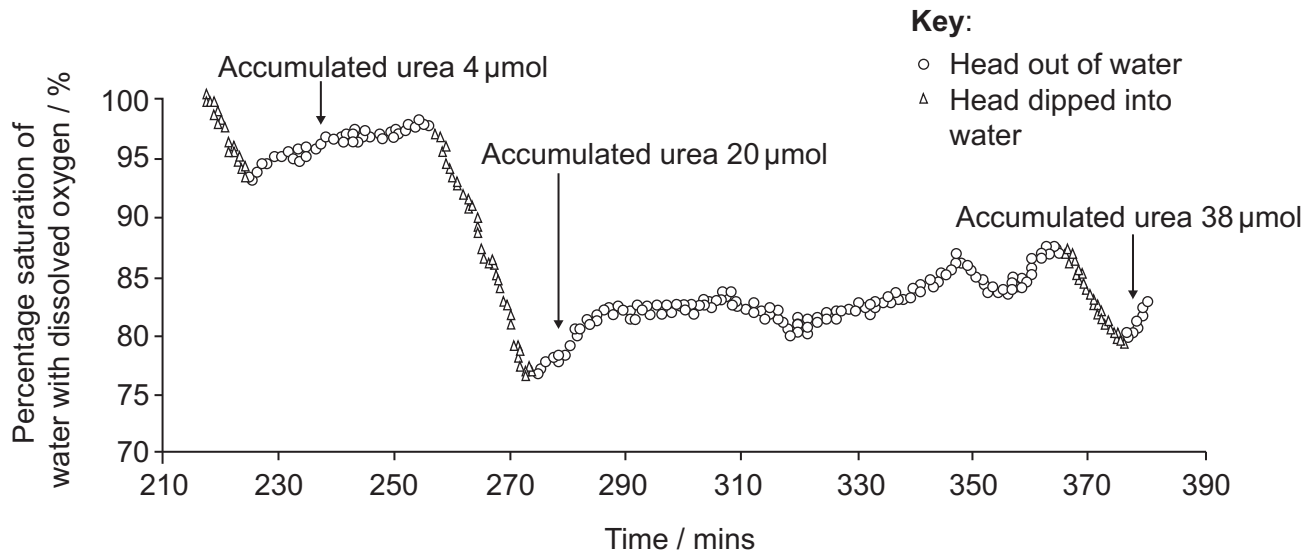
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**(Question 1 continued)**

It was noted that during long periods out of water, turtles rhythmically moved their mouths to take in water from a shallow source and then discharge it. Changes in the dissolved oxygen and the quantity of accumulated urea in the rinse water discharged by the turtles were monitored over time as shown in this graph.



[Source: adapted with permission from Y. Ip *et al.* (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733.]

- (c) (i) Describe the trends shown by the graph for dissolved oxygen in water discharged from the mouth. [1]

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- (ii) Suggest reasons for these trends in dissolved oxygen. [2]

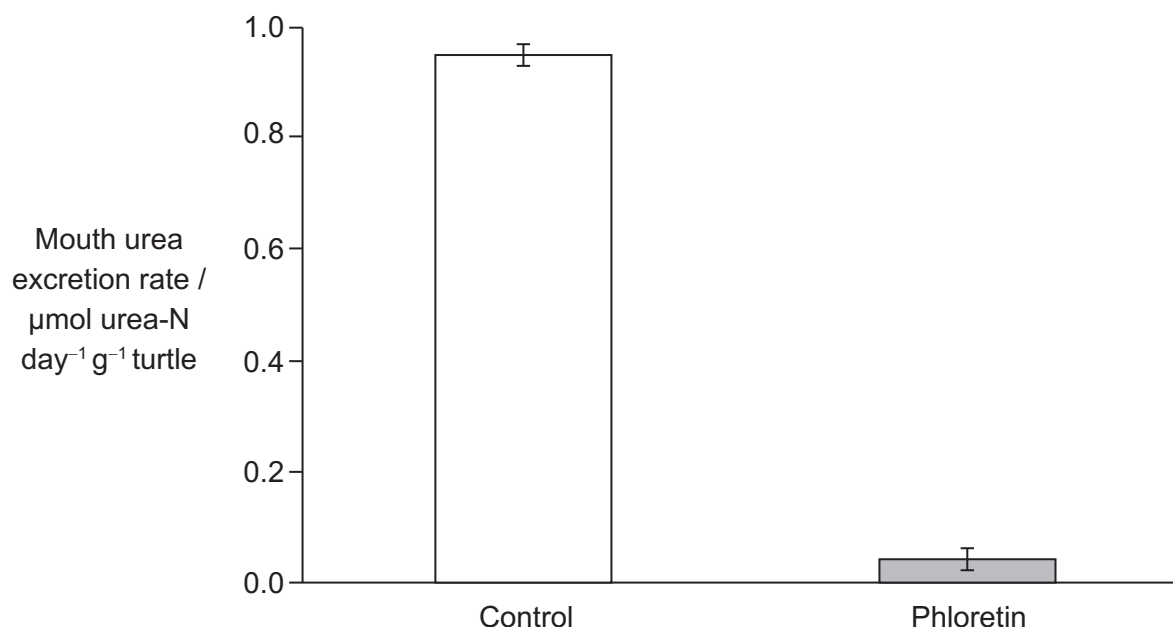
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**(Question 1 continued)**

In order to test whether a urea transporter was present in the mouth tissues of the turtles, phloretin (a known inhibitor of membrane proteins that transport urea) was added to the water in which a further set of turtles submerged their heads. The results of that treatment are shown.



[Source: Reproduced with permission from Y. Ip *et al.* (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733. [jeb.biologists.org](http://jeb.biologists.org).]

- (d) Deduce with a reason whether a urea transporter is present in the mouth of *P. sinensis*. [2]

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Answers written on this page  
will not be marked.



**(Question 1 continued from page 5)**

Further research was conducted to determine where mRNA expression of a urea transporter gene might be occurring in *P. sinensis*. Gel electrophoresis was used to analyse different tissue samples for mRNA activity.

Roof of the mouth	Tongue	Esophagus	Intestine	Kidney	Bladder
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[Source: Reproduced with permission from Y. Ip *et al.* (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733. [jeb.biologists.org](http://jeb.biologists.org).]

- (e) Outline the additional evidence provided by the gel electrophoresis results shown above.

[2]

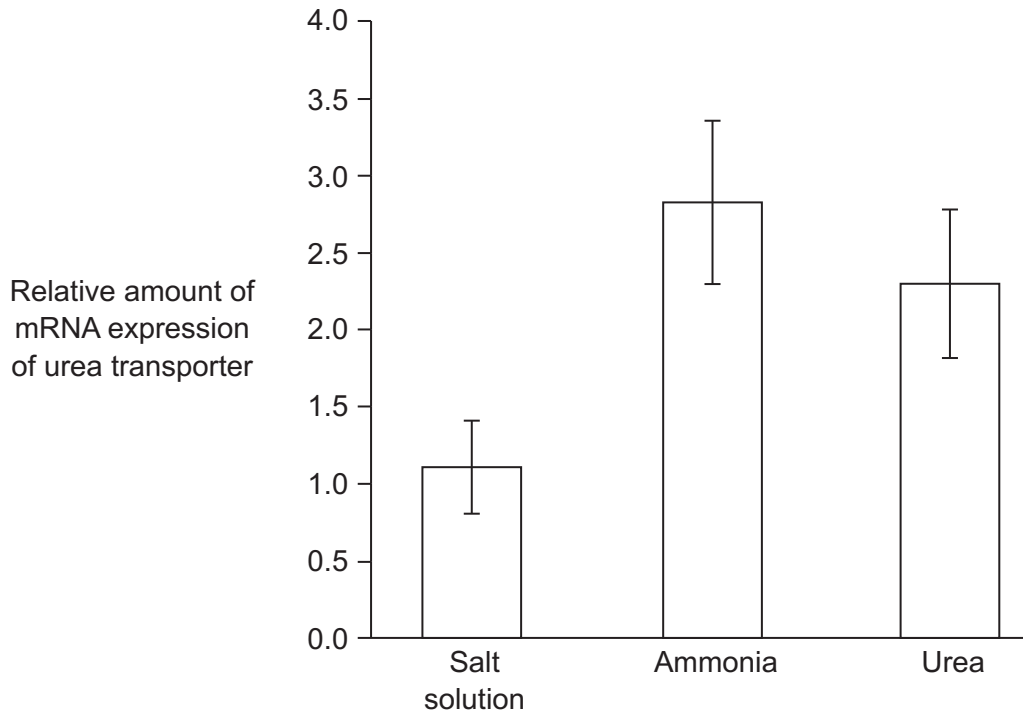
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**(Question 1 continued)**

Expression of the urea transporter gene by cells in the turtle’s mouth was assessed by measuring mRNA activity. Turtles were kept out of water for 24 hours and then injected with either a salt solution that matched the salt concentration of the turtle, dissolved ammonia or urea, followed by another 24 hours out of water.



[Source: © International Baccalaureate Organization 2017]

- (f) (i) Identify which of these turtle groups represent the control, giving a reason for your answer.

[1]

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**(Question 1 continued)**

- (ii) Suggest a reason for the greater expression of the gene for the urea transporter after an injection with dissolved ammonia than an injection of urea.

[2]

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- (g) The salt marshes where these turtles live periodically dry up to small pools. Discuss the problems that this will cause for nitrogen excretion in the turtles and how their behaviour might overcome the problems.

[3]

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2. (a) Nucleosomes help to regulate transcription in eukaryotes.

(i) State the components of a nucleosome.

[1]

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(ii) State a chemical modification of a nucleosome that could impact gene expression.

[1]

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The image below shows the structure of one type of tRNA based on X-ray crystallography studies.

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(Question 2 continued)

(b) Outline the functions of the **two** binding sites on the tRNA.

[2]

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(c) Outline what happens to the proteins produced by free and bound ribosomes.

[2]

Free ribosomes: .....

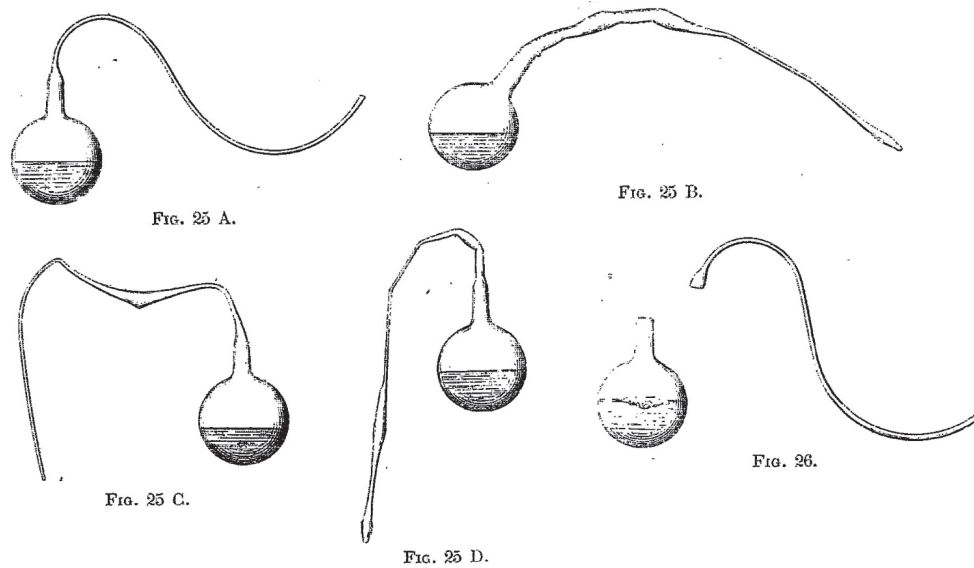
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Bound ribosomes: .....

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3. Pictured below are Louis Pasteur's original drawings of swan-necked flasks.



[Source: L Pasteur and L Pasteur Vallery-Radot, (1922), *Œuvres de Pasteur*, Vol II *Fermentations et générations dites spontanées*, pages 260–261]

- (a) Describe how Pasteur's experiments provided convincing evidence to falsify the concept of spontaneous generation.

[3]

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**(Question 3 continued)**

(b) State the function of life in *Paramecium* that is carried out by:

(i) cilia.

[1]

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(ii) the contractile vacuole.

[1]

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(c) Discuss the advantages and disadvantages of the use of adult stem cells.

[3]

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4. Carbon dioxide is released to the atmosphere when microorganisms decompose organic matter in thawing Arctic soil. The graph shows the rate of release of carbon dioxide at different soil temperatures during a moderate thaw.

Please go to: <http://www.nature.com/nature/journal/v459/n7246/full/nature08031.html>

- (a) Outline the effect of increased carbon dioxide release on global climate change. [1]

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- (b) Most of the surface of the Earth is covered with a wide diversity of ecosystems. Outline **two** general characteristics of all ecosystems. [2]

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**(Question 4 continued)**

(c) Vascular plants can be found in a wide variety of ecosystems.

(i) Outline active transport in phloem tissue.

[2]

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(ii) Explain how a plant replaces the water it loses in transpiration.

[3]

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## Section B

Answer **two** questions. Up to one additional mark is available for the construction of your answers for each question. Write your answers in the boxes provided.

5. Oxygen is needed to complete aerobic cell respiration.
  - (a) Explain how chemical energy for use in the cell is generated by electron transport and chemiosmosis. [8]
  - (b) Outline **four** different functions of membrane proteins. [4]
  - (c) Distinguish between anabolism, catabolism and metabolism. [3]
  
6. Defence occurs on the micro and macro levels.
  - (a) Describe the functioning of immunoglobulins. [3]
  - (b) Outline how antibiotics offer protection from certain forms of infectious disease. [4]
  - (c) Coughing to clear the airways is accomplished by muscle contractions. Explain muscle contraction. [8]
  
7. The biological insights of Mendel and Darwin in the 19th century remain important to this day.
  - (a) Discuss the role of genes and chromosomes in determining individual and shared character features of the members of a species. [7]
  - (b) Outline the process of speciation. [4]
  - (c) Describe, using **one** example, how homologous structures provide evidence for evolution. [4]



















